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(71)Applicant : INFINEON TECHNOL NORTH AMERICA CORP

(72)Inventor : CZAJA STANISLAW
ANDERSON KRAIG

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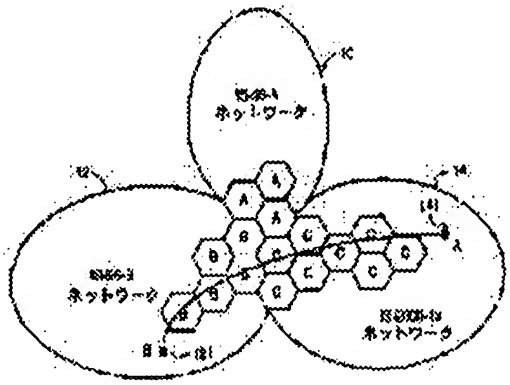
(54) METHOD FOR ACTUALIZING SOFT HANDOFF BETWEEN GENERATIONS, MOBILE STATION, AND RADIO TELEPHONE SYSTEM

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a handoff between two different generations of a CDMA system.

SOLUTION: As a mobile station move from one generation 121 to the other generation 141 of a network, current service to the mobile station is forcibly cut off by a hard handoff before the service is re-established on the network of the other generation. In this invention, the standard message structure proposed in IS.2000 is corrected for a forward link and a smooth shift of service when the mobile station moves from one service area (i.e., 2G) to the other service area (i.e., 3G) is enabled by SHO, i.e., a 'make-before-break' system.



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* NOTICES *

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2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001] This application is the U.S. provisional application number of December 2, 1998 application. 60/110,666 Priority is asserted based on a number specification "Forward Link Inter-Generation Soft Handoff Between 2G and 3G CDMA Systems."
[0002] This invention relates to the approach of the software hand off which carries out a forward link between the code division multiple access (CDMA) systems of the second generation (2G) and the third generation (3G) more about communication system at a detail.
[0003] Usually, one of the cellular type radiotelephony communication system of the format used is called a code division multiple access (CDMA) system. A radio signal shares the same frequency spectrum between a CDMA system to coincidence, and this is contrastive with the Frequency Division Multiple Access (FDMA) of precedence, or a time division multiple access (TDMA) system. One of the CDMA standards at present and the so-called second generation standard, 2G [i.e.,], are called TIA/EIA-95-A/B (or IS-95-A/B), and they are referred to in this specification. A new third generation (3G) CDMA standard is proposed more nearly recently, and it is referred to as IS-2000 (it is IS-95-C before) or CDMA2000, and is referred to in this specification. When new 3 G systems are incorporated, in cellular system, both old 2 G systems and a new 3G compatible system will be intermingled.
[0004] A mobile station communicates with the base station which has the most powerful usable signal in typical CDMA cellular type radiotelephony communication system. In order to pursue an usable signal, a mobile station holds the list of usable base stations. Specifically, each base station in a CDMA system transmits the "pilot" signal which is not modulated on the predetermined frequency of a lot. A mobile station receives the pilot signal and it judges which pilot signal is the strongest. Usually, the "searcher" equipment in a mobile station performs signal detection and a measurement function on the strength.
[0005] The result from a searcher is reported to a base station (that is, it is active) at present. Next, it is directed that the base station updates the list of usable base stations which the mobile station holds to the mobile station. The list is divided into three functional groups. That is, they are an active set (active set), the Kandy date set (candidate set), and the Neber set (neighbor set). An active set includes the list of base stations where the mobile station is communicating at present (1-4 base stations are included typically). The frequency of a monitor is lower, although the Kandy date set is the list of base stations which may move to an active set and the Neber set is a list of base stations by which the monitor is carried out.
[0006] If a mobile station moves and the signal of a base station active at present becomes weaker, a mobile station must be accessed in a new base station. Based on the result from a searcher, and the directions answered from the base station, a mobile station updates said set and communicates with another base station. In order to perform communicative transmission so that there may be no joint for the user of a mobile station, the hand off of the communication link must be carried out to the next base station. Ideally, this hand off establishes a new link, before terminating the 1st link. The hand off of this format is known as a software hand off (soft handoff =SHO) or "front [cutting] connection (Make-

Before-Break)."
[0007] Now, SHO cannot be performed between two different CDMA system generations. 3 G systems are designed so that it may have 2 G systems and compatibility in signaling and call-processing level. However, since these two systems use a different modulation technique and a different diffusion coefficient, they are inevitably incompatible in the physical layer. Therefore, the hard hand off known also as a "front [connection] cutting (Break-Before-Make)" method on the service boundary of 2G and 3G is proposed.
[0008] In this format of a hard hand off, the connection with a base station (namely, 2G) active at present is ended, before new service with a new base station (namely, 3G) is established. Interruption of such service reduces the quality (quality of service =QOS) of service to a cellular type telephone user. In this scenario, when the mobile station is offering voice service, degradation of the quality of voice unpleasant for a user will arise in all probability, and a call may be lost. When a mobile station is during data transfer, it becomes easy to produce delay (transmission error sake) of remarkable transmission. In a standard at present, before service is recovered, at least ten frames is actually lost.
[0009] Therefore, in order to avoid un-arranging in relation to the hard hand off method proposed at present, offering the software hand off between two different generations of a CDMA system is called for.
[0010] This invention is correction of specification IS-2000 proposed, and this is for realizing the software hand off in a forward link between two different generations of a CDMA system. This invention makes it possible to correct the message structure proposed and to report the generation format of a base station as a whole. Not only two different examples but two kinds of possible software hand off procedures are indicated. although this invention is not limited to the advantageous example currently indicated, this contractor adapts himself easily in instruction of this invention -- making -- other examples and applications -- ******** -- things are possible.
[0011] In the 1st example, the system configuration parameter is added to the general hand off prompting message (General Handoff Direction Message) and the extended mold hand off prompting message (Extended Handoff Direction Message). The Neber list message (Neighbor List Message) and an extended mold Neber list message (Extended Neighbor List Message) are updated so that the information about the base station of both systems may be included. The hand off between the systems between generations is performed by the software hand off of a selection mold (selection based). Said selection is due to the signal strength of the received pilot signal.
[0012] In the 2nd example, four parameters are added to the PILOT_PN record of a general hand off prompting message. said four parameters -- a generation discernment parameter, a wireless configuration parameter, and a cutoff timer parameter -- and it comes, and it intercepts and is [it is and] a value parameter. Based on the value of a generation discernment parameter and a wireless configuration parameter, either the software hand off of a selection mold or a true hand off is performed. Before a true hand off intercepts a base station at present, is more powerful and also it chooses a generation's base station, it combines the signal from both generations' system. A cutoff parameter is used in order to offer the superposition of sufficient time amount to two different base stations, and a system designer is enabled to tune up a network.
[0013] In being prepared in order to enable this contractor to use this invention, and realizing this invention, the following explanation shows the format which an artificer considers is best. However, it is clear for this contractor that there is room of various modification.
[0014] A second generation (2G) CDMA system at present is called a TIA/EIA-95-A/B (or IS-95-A/B) system, is upgraded, and, finally is permuted by the third generation (3G) CDMA system. By the new modulation technique, the air interface of 3G (IS-2000) system also makes possible a spreading factor which is different in addition to better spectrum effectiveness. However, it is required that some new 3 G systems which operate within the same channel bandwidth as old 2 G systems should have 2 G systems and compatibility in signaling and call-processing level. However, as for the reverse link of 3 G systems, the reverse link of 2 G systems uses the recovery which is not coherent to using a coherent recovery. Therefore, by 3G specification, the attempt which gives compatibility to two systems in the

physical layer was not made.
[0015] Furthermore, the forward link of two systems uses a different modulation technique (QPSK (3G) and BPSK (2G)), and, for this reason, some correction is required in the demodulator of new 3 G systems. However, since IS-2000 terminal (namely, mobile station) must be able to operate in an IS-95-A/B network, its 3G new terminal needs to be automatically switchable in an actuation method to the system of one system to another side.
[0016] In fact, it is not practical to perform the reverse link SHO between 2G and 3 G systems. This is because 3G base station is unable to restore to 2G reverse link and the reverse is also impossible (are coherent non-coherent one, a different modulation, in addition to this). However, in this invention, the method of performing SHO in a forward link is indicated, and this can be realized by making small correction of mere some to 3 G systems proposed.
[0017] In addition to this, the receiver of a mobile station consists of a "rake" receiver and two or more components. A rake receiver consists of two or more demodulators (to a short range CDMA, it is at least three) (or "finger"). This identifier is attached, in order for two or more of these demodulators or fingers to function like the rake for horticulture and "to gather up (rake) up" up a signal. The multi-pass component received from the single base station or the signal from two or more base stations (it is the number of the demodulators in said rake receiver at the maximum) is independently pursued in each demodulator, and there is capacity to which it restores in it. Therefore, it is possible to constitute one demodulator according to 2G standard, and to constitute other at least one demodulator according to 3G standard. Thus, a single mobile station can be used by the whole system by which the generation was intermingled.
[0018] The arrangement model of 3 G systems consists of partial superposition of 2G (IS-95-A/B) networks 10 and 12 at present and 3G (IS-2000) new network 14 in one of the advantageous examples. This is shown in drawing 1 . Before the mobile station carries out reestablishment of the service on the network of the generation of another side, according to the hard hand off proposed, it is forced to intercept service at present, as a mobile station moves to the generation 141 of another side from one network generation 121. In this invention, in order to offer SHO to a forward link, a small number of correction is added to the standard message format proposed in specification IS-2000. In order to enable the report of 3G base station, specifically, it is proposed that a message structure makes it change. Therefore, the software hand off between the systems of two generations becomes possible by this invention, and QOS can be held across a generation's boundary.
[0019] This invention forms the mechanism which gives the information about a surrounding network to a mobile station. For example, it is the information any of 2G/[2G 3G, or] 3G mixture network parameters (data transfer rate etc.) and a network are. This can be attained by adding the 1-bit field in a general hand off prompting message and an extended mold hand off prompting message. Additionally, each base station in the area where 2G/3G services overlap must store all the base stations of an alien system in the Neber list message and an extended mold Neber list message, and must be placed. This is a new definition. NGHBR_CONFIG It is attained by adding to the field.
[0020] Advantageously, in network arrangement, the same base station controller manages two different generations' base station. Therefore, in the area where generations overlap, the Neber list message and an extended mold Neber list message contain the system of both formats. The definition of the Neber list messages 20 and 30 is shown in drawing 2 and drawing 3 . And although the Neber configuration table 40 is corrected like drawing 4 , the item of the underline section is the proposed example of correction here. Specifically, the items 401 and 402 about two new channel configurations are added (it is one at a time to 2G and each 3 G system).
[0021] After reception of the Neber list message or an extended mold Neber list message, a mobile station measures the pilot signal in activeness, the Kandy date, and the Neber set, and reports reinforcement to a base station using a pilot on-the-strength measurement message (Pilot Strength Measurement Message). This procedure is performed by the searcher and a searcher is calculated by adding the rate to the total receiving spectral density (a noise and signal) Io of the pilot energy Ec per [which was received in each pilot wave's reinforcement] chip.

[0022] In a base station, which a pilot wave's that was detected and reported is connected with the 2nd or a third generation system, or since it is known, forward link SHO capacity can be employed using this information. Specifically, a compatible base station is added to the active set of a mobile station. This is performed through a general hand off prompting message (GHDM) and an extended mold hand off prompting message (EHDM). The field 51 which shows the generation (2G, 3G) of the PILOT_PN record 50 with relation is also added. The PILOT_PN record 50 of a message can be corrected and shows an example to drawing 5 . The field "2G / 3 G_CHAN_CONFIG" of the underline section is added.
[0023] Before directing that a GHDM message should be sent out to a mobile station and the forward link SHO between 2G and 3 G systems should be performed, a base station controller assigns a required channel resource to each of two systems (as already stated, in order that the same controller may manage both generations).
[0024] Since each mobile station has at least three demodulators (finger) in a rake receiver, it assigns one of the fingers to the signal which comes from 2G base station and to which it restored. On the other hand, the remaining fingers restore to the signal which comes from 3G base station (or this reverse). According to the proposed specification, the recovery of an IS-95-B signal must be possible for each IS-2000 mobile station, therefore it is possible to modulate two signals independently (in superposition arrangement (overlay deployment), two modulating signals intersect perpendicularly mutually). Furthermore, since the request on an operation (channel decryption) and the INTARIBA memory of IS-2000 mobile station are large, the capacity which restores to them and decrypts two independent channel configurations (in order to maintain the maximum data transfer rate) is included in the capacity of the mobile station defined at present.
[0025] According to the example of this invention, a SHO procedure is performed as follows.
[0026] 1. When a mobile station is in the area where 2G and 3G overlap, a mobile station includes the pilot wave belonging to both systems in the Neber list message (NLM).
[0027] 2. A mobile station measures the pilot reinforcement of all base stations (2G and 3G), and reports it to a base station.
[0028] When it is a 3.2G (or 3G) pilot Ec/Io>T_ADD threshold, a base station includes this pilot wave in the active list of mobile stations.
[0029] 4. A mobile station continues restoring to allocation of the base station of a generation at present.

[0030] 5. A mobile station assigns one or more recovery fingers to an "other generation" base station signal, and performs an informational recovery and an informational decryption independently of allocation at present.
[0031] 6. After decrypting the 1st good frame from an "other generation" base station, A mobile station starts Tm counter and a timer reports the event to be expired within a hand off completion message (Handoff Completion Message) (Tm counter). 7. which must be defined as being used for decision of SHO timing -- a base station intercepts an "other generation" pilot wave (channel) from the active set of a mobile station, therefore SHO completes it here.
[0032] An above-mentioned example is SHO SHO (ISBSHO) of a selection mold, i.e., the selection mold between generations. That is, in the overlapping area, a mobile station receives two base station signals (from each generation to one), and it is decided which signal is more powerful. The base station where a signal is the strongest is chosen and a weaker signal is intercepted as mentioned above.
[0033] SHO of the 2nd format is called "true" SHO in this specification. as defined by this detail in the letter, that true SHO arises is the case where two signals from two different generations' system are actually together put before one side is intercepted. Now, the finger is assigned to each multi-pass component while the mobile station is communicating with the base station. A signal is together put, before a bit is decrypted. true SHO of this invention -- at least one finger -- "-- others -- it assigns" generation's signal. After a signal gets over and an interleave is carried out, a software symbol is combined and compound-ized, and this allocation is performed so that an output bit may be generated. Therefore, unlike the 1st example of this invention, in the overlapping area, a mobile station uses

actively two signals from the base station between two different generations for coincidence. once one signal becomes weak too much, if signal strength falls to below a threshold namely,, the signal will be intercepted and a mobile station will communicate only with a more powerful base station.
[0034] However, only in the case that the coding rate of two different signals is the same, true SHO approach can be used. When coding rates differ, a signal must be decrypted sequentially and must use SHO of a selection mold. Therefore, in the environment where a generation and a signal are intermingled, the SHO method of a selection mold is sometimes required. However, it is more advantageous when true SHO can be performed. Although the 2nd example of this invention is explained below, true SHO is performed when possible here.
[0035] The case where the software hand off between generations of each format is allowed is described in the table shown in drawing 6 at a detail. As shown in a table, 3 G systems have five or more kinds of data transfer rates to 2 G systems supporting two kinds of data transfer rates (RS-1 and RS-2). When the rate of coding transmitted by both forward links other than SHO between RS-1 <=>RC-1 and RS-2 <=>RC-2 and data transfer is the same like illustration (namely, RS-1 <=>RC-4), true SHO (SHO) can be performed. The data transfer rate of both forward links can perform the selection mold software hand off (ISBSHO) between generations, when coding rates differ, although it is equal (namely, RS-1 <=>RC-3 and RS-2 <=>RC-5). based on a data transfer rate and a coding rate, addition of a new configuration applies this invention so that this detail in the letter may explain.
[0036] In case true SHO is performed, a mobile station assigns an IS-95-A/B base station signal and the remaining fingers to the recovery of an IS-2000 base-station signal for one or more fingers. According to the modulation and diffusion parameter of each base station, it restores to an input signal, and although the symbol to which it restored is together put by the maximum ratio (maximum ratio =MR) method before a decryption, this of it is the same as that of the usual SHO. DEPANKUCHA (de-punctured) of the symbol is carried out to the rate of RC-4 after the recovery of 2700bps and 1500bps -- having -- and -- an information symbol -- (-- a CRC symbol -- not but --) -- it is put together. In case ISBSHO is performed, according to the modulation and diffusion parameter of IS-95-A/B and IS-2000 base station, it restores to an input signal. The signal component from the same base station is added in MR coupler, and is sequentially decrypted by the decoder. Then, the best frame is chosen based on the quality of a frame.
[0037] IS-2000 mobile station receives both IS-95-A/B and IS-2000 signals, and since it can get over, it can restore now to the signal from both generations to coincidence by the simple escape of a message structure, and, thereby, a software hand off becomes possible. This can be attained by adding the four new fields to the PILOT_PN record 70 of a general hand off prompting message. The following four new parameters are :generation discernment parameter (IS-95B_IS -2000) 71 added to the PILOT_PN record 70 of a general hand off prompting message, the wireless configuration parameter (RADIO_CONFIG) 72, the generation cutoff timer parameter (IG_T_DROP) 73, and the generation cutoff threshold (IG_DROP_TSHD) 74. These parameters added are shown in the table of drawing 7 .
[0038] The IS-95B_IS-2000 field 71 is used in order to identify the generation (2G or 3G) of a base station. The RADIO_CONFIG field 72 specifies a data transfer rate, a diffusion coefficient, and a coding rate (namely, all modulation parameters). For example, if the IS-95B_IS-2000 field 71 "0" (2G) Becomes, a data transfer rate will be specified in the RADIO_CONFIG field 72 only using 1 bit. In this case, to RS-1, it is "1" to "0" and RS-2. If the IS-95B_IS-2000 field 71 "1" (3G) Becomes, it will define which configuration the RADIO_CONFIG field 72 can apply (RC-1-RC-5). Since 3G additional configuration can be considered, the RADIO_CONFIG field 72 is shown by the advantageous example as 4 bits. However, even if it uses bits fewer than this, a bit may be added further and you may prepare for more configurations.
[0039] The IG_T_DROP field 73 is a timer used in order to measure the die length of SHO. For example, the IG_T_DROP timer 73 is realized dynamically and, thereby, each base station specifies each value independently. It enables this "to tune up" up a network dynamically. In an advantageous example, the number of the range of the value of the IG_T_DROP timer 73 is 0-15. Finally, the IG_DROP_TSHD field 74 is a threshold, and in order to decide when a base station is intercepted, it

uses energy measured value. Specifically, the time of the IG_DROP_TSHD field 74 becoming weak for using Ec/Io energy measured value and a signal using it too much, therefore intercepting is judged. In an advantageous example, although the IG_T_DROP timer 73 is used to the selection mold SHO, the threshold 74 of IG_DROP_TSHD is used to true SHO. However, in order to make a SHO device into a precision further, both two measured value may be used. Cutoff of the signal which is once one side tunes up a mobile station so that only the base station of another side may be used.

[0040] According to the advantageous example of this invention, a SHO procedure is performed as follows.

[0041] When a mobile station is within limits which IS-95-A/B-IS -2000 overlaps, the pilot wave belonging to both generations is contained in the Neber list message (NLM) or the renewal message of the Neber list (Neighbor List Update Message =NLUM).

[0042] A mobile station measures the pilot reinforcement of all base stations (2G and 3G), and reports the reinforcement to an active base station by the pilot on-the-strength measurement message (PSMM).

[0043] If Kandy date pilot Ec/Io between generations reported by the PSMM message is larger than a T_ADD threshold, a base station is included in the GHDM message which directs the generation, wireless configuration, and hand off parameter of a system for this pilot wave.

[0044] A mobile station assigns one or more recovery fingers next to an "other generation" base station signal, and performs an informational recovery and informational decode depending on a wireless configuration and a hand off parameter. transmission (SHO which is shown in drawing 6 and which is allowed is used) according [a mobile station] to the link of a generation "at present" if all the hand off requests between generations specified in the GHDM message (IG_T_DROP and/or IG_DROP_TSHD) are filled -- ending -- "-- others -- transmission by" generation's link is started.

[0045] A mobile station completes the hand off between generations by sending out of a hand off completion message.

[0046] The computer simulation of true SHO is shown in drawing 10 and drawing 11 . Simulation was performed in the environment where AWGN and phasing exist. To the case where there is AWGN, the simulation parameter was set up, as shown in drawing 8 . When the path from an IS-95B base station is only only one, the curve of RS-1 shows FER. RS-1 <=>RC-4 curve shows gain, when the number of the paths from each base station is one in the true SHO scenario between generations. Although a simulation parameter is shown in drawing 9 when phasing occurs, the rate of a mobile station is set as 30 km/h here. To an environment with phasing, when the path from an IS-95B base station is only only one, RS-1 curve shows FER. When the number of the paths from each base station is one in the true SHO scenario between generations, RS-1 and RC-4 curve shows gain. Simulation was not performed, in order to be easier for this contractor to understand the gain of the engine performance of ISBSHO and to be dependent only on the strength of the link from each base station of two different generations.

[0047] This invention offers the easy device which makes easy the software hand off between generations of a forward traffic channel in the CDMA cellular type radiotelephone system with which a generation is intermingled as mentioned above. By including the true software hand off between generations in IS-2000 specification, arrangement of 3 G systems can be simplified remarkably. This is because an IS-95 B channel element does not need to be included in IS-2000 base station. Moreover, a software hand off conquers the fault of the hard hand off procedure proposed, without increasing the complexity and the hardware request of a system. Each IS-2000-1x mobile station must already be able to restore to an IS-95B signal, and about two different generations' signal, since it can get over independently, a mobile station does not become still more complicated.

[0048] The example of the CDMA system 120 by which this invention was incorporated is shown in drawing 12 . The mobile station 124 shall communicate with the 1st base station 122. The hand off of it must be carried out to the nearer base station 123 as a mobile station moves. When new 3 G systems are introduced, in the CDMA system 120, both 2G and 3 G systems will be intermingled. According to this invention, the common base station controller 121 controls both 2G and 3G base stations 122 and 123. For example, the 1st base station 122 is 2 G systems in this case, and the 2nd base station 123 is 3 G systems.

[0049] If a mobile station 124 and the 2nd base station 123 are constituted according to this invention, a mobile station 124 will form a forward link with the 2nd base station 123, before ending a link with the 1st base station 122. This "software hand off" raises QOS of a mobile station as compared with a hard hand off. This improvement can be attained to an interesting thing, without complicating hardware remarkable.

[0050] This contractor will understand that application and modification are variously possible, without deviating from the range of this invention from the advantageous example indicated in this specification. For example, in order to obtain the result indicated on these specifications, and the same result, even if it adds an additional message, the data structure in specification IS-2000 proposed may be corrected. Furthermore, this invention may be extended to implementation of European CDMA, and, thereby, the software hand off between GSM and W-CDMA is made possible. Therefore, this invention is realized by different method from the method concretely indicated in this specification within the limits of the attached claim.

[Translation done.]